

THE OCCURRENCE OF NEW ARCTIC-ALPINE SPECIES
IN THE BEARTOOTH MOUNTAINS,
WYOMING-MONTANA

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During three summers of field work, 1958–1960, in the Beartooth Mountains, Wyoming-Montana, an extensive study was made of the alpine plant communities in relation to cryopedogenic (soil frost) processes and patterns (Johnson and Billings, 1962). Extensive alpine tundra is found in these mountains between elevations of 10,000 and 12,000 feet. The range is traversed by United States Highway 312 northeast of Yellowstone National Park. This study was concentrated on the southern end of the mountain range because of the better developed vegetation, the diversity of patterned ground features, and accessibility. From field observation the Beartooth tundra in Wyoming appears to have received much less glaciation than farther north in Montana which may account for the floristic diversity. Of particular interest are the numerous alpine bog habitats which are decidedly less frequent in the Rocky Mountain alpine zone than in Arctic regions. Many of these bog habitats are underlain with permafrost within three feet of the surface.

As a group the thirteen species discussed herein are of particular ecological interest because they are known primarily from the North American Arctic flora. It seems apparent that bog habitats and solifluction slopes have served as a refugia for Arctic plants since the last glacial period. The present hypothesis is that a bog environment is capable of dissipating the present excessive summer heat load by the high latent heat of vaporization associated with evaporation from a wet site. This hypothesis is analogous with the investigations of Dahl (1951) in Scandinavia where the lower altitudinal limit of many alpine species is correlated with maximum summer temperatures. It is probable that this correlation affects the plant through a critical maximum temperature as suggested by field studies of photosynthetic and respiration processes (W. D. Billings, personal communication).

Seven species, *Phippsia algida*, *Carex misandra*, *Kobresia macrocarpa*, *Eriophorum callitrix*, *Koenigia islandica*, *Rumex acetosa*, and *Draba glabella*, are new records in the Beartooth Mountains and in Wyoming. The remaining six species, *Festuca baffinensis*, *Kobresia bellardii*, *Carex capitata*, *C. nelsonii*, *Juncus albescens*, and *J. castaneus*, are new records in the Beartooth Mountains and rare species in Wyoming. Only *Carex capitata* and *Rumex acetosa* have been reported from Montana.

PHIPPSIA ALGIDA (Phipps) R. Br. is a densely caespitose plant having boat-shaped leaf tips and resembling a small *Poa*, but it is a member of

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the tribe *Agrostideae*. The plants are relatively common only in wet sand or gravel at the base of late melting snowbanks. These sites, drenched with snowmelt water most of the growing season, are subjected to considerable needle-ice activity throughout the summer and fall. *Phippisia* forms an open community between alpine bog vegetation and late snowbeds devoid of plants. *Koenigia islandica* L. and *Epilobium alpinum* L. are frequent associates. The species, according to Porsild (1952), is strongly nitrophilous. It has a circumpolar, widespread, high Arctic distribution, and has also been collected at several sites in Clear Creek County, Colorado (Harrington, 1954). Collections were made on both sides of Beartooth Pass; one in the head of Wyoming Creek (18 July 1960, *Johnson 168*), and another east of Frozen Lake (10 August 1960, *Johnson 219*).

CAREX MISANDRA R. Br. is common to infrequent on slightly raised mineral soil within wet sedge bogs. It was found associated with *Kobresia macrocarpa* Clokey and *Poa longipila* Nash. The plants are densely caespitose with 3–5 spikes on long slender, often drooping peduncles. The species is known to have a circumpolar, high Arctic distribution, however, Harrington (1954) reports collections from north central Colorado and from northern Utah (Lewis, 1958). Collections were made on a solifluction terrace in the head of Wyoming Creek (5 August 1960, *Johnson 204*, and 10 August 1960, *Johnson 233*).

KOBRESIA MACROCARPA Clokey [*K. bellardii* var. *macrocarpa* (Clokey) Harrington] is an alpine sedge relative previously reported only from central Colorado (Harrington, 1954). It differs markedly from *K. bellardii* in having a larger inflorescence, stouter culms and wider leaves. No intergradation was observed. Both species are apparently rare in Wyoming, although they are close associates in the Beartooth tundra on well developed soils in alpine turf. The collections are: 30 August 1960, *Johnson 184* on a gentle slope east of Twin Lakes; 5 August 1960, *Johnson 205A*, and 10 August 1960, *Johnson 233A* from a sedge meadow on a solifluction terrace in the head of Wyoming Creek; and 20 August 1960, *Johnson 257* from a steep northwest slope north of Gardner Lake.

ERIOPHORUM CALLITRIX Cham., a cotton grass, is confined to three bog sites east of Beartooth Pass. Two of these sites are known to be underlain with permafrost. The species is codominant with *Carex scopulorum* Holm on water-saturated peats formed behind solifluction terraces. The plants form individual tufts with solitary spikelets subtended by black to lead-colored spathes and scales. The species is widely distributed in the North American Arctic and subarctic regions, but no previous reports are known from the Rocky Mountains according to Porsild (1952). The collections are: 21 June 1958, *Johnson 58B* and 27 July 1958, *Johnson 58* from near the head of Twin Lake cirque; 24–30 July 1959, *W. M. Johnson*, near the head of the North Fork of

Popo Agie Creek in the Wind River Mountains, Fremont County, Wyoming (identified by A. E. Porsild).

KOENIGIA ISLANDICA L. is one of the few annuals in the Arctic-alpine flora. The plants, which seldom exceed 3 cm. in height, are locally very numerous in saturated sands, moss mats and organic soil which receive snowmelt water throughout the summer. *Koenigia* may extend into wet sedge meadows around the base of sedge hummocks, but it is mostly confined to the margins of alpine bogs, lake shores, and stream drainages adjacent to late snowbeds. The one or two pairs of sessile cauline leaves and the terminal, apetalous flower of plants exposed to direct sunlight develop more anthocyanin pigment than plants growing in partial shade. The distribution of this plant is considered circumpolar, low Arctic. It has recently been collected at several alpine stations in Colorado including Mount Evans and Rocky Mountain National Park. The species was observed at several sites on both sides of Beartooth Pass (4 August 1959, *Johnson 116*).

RUMEX ACETOSA L., green sorrel or sour dock, is naturalized from Europe throughout much of temperate, eastern North America. It appears, however, to be native in the American Arctic. A single record is known from Glacier National Park, Montana (6 July 1922, *J. W. Severy 36*) along Gunsight Pass Trail. The only plants of the species encountered recently were growing in moist alpine turf on a steep northwest slope north of Gardner Lake (26 July 1958, *Johnson 63B*). It is assumed that this collection represents a southern range extension of native Arctic populations rather than an introduced weed, since the plant is not otherwise known to occur in Wyoming.

DRABA GLABELLA Pursh is the probable identification of a collection which has been tentatively confirmed by Dr. Reed C. Rollins of the Gray Herbarium (Rollins, 1961). If true, this site represents a long southern extension of its known Arctic distribution. Porsild (1952) reports the species as, "strongly nitrophilous, favouring animal dung." The widely scattered plants were growing in sheep trails on a very steep, exposed northwest slope north of the highway at Gardner Lake (8 July 1959, *Johnson 112*).

It should be pointed out that this species is in addition to eleven alpine *Draba* species reported by Rollins (1953) from Clay Butte, a glacial monadnock of sedimentary rocks seven miles west of Beartooth Pass. Five of these species and *D. glabella* were collected from granitic parent material in the course of this study (Johnson and Billings, 1961).

Several additional collections from the Beartooth Mountains are from similar habitats. Thanks to the annotations of Dr. A. E. Porsild, *Festuca baffinensis* Polunin, is now distinguished from *F. brachyphylla* Schult. by a culm which is puberulent on the upper half and a usually shorter, dark purple panicle. A previous collection from Park County, (*Porter*

& *Rollins 5875*) has been so annotated. The present collection (5 August 1960, *Johnson 203*) is from a frost boil in the head of Wyoming Creek.

KOBRESIA BELLARDII (All.) Degland [by some, *K. myosuroides* (Vill.) Fiori and Paol.] was first collected in Wyoming near the head of the North Fork of Popo Agie Creek, Fremont County in the Wind River Mountains (24–30 July 1959, *W. M. Johnson*). It is now recorded from Park County (30 July 1960, *Johnson 185*) from a gentle alpine slope east of Twin Lakes. It was associated with, but distinct from, *K. macrocarpa*. In the Colorado alpine tundra, *K. bellardii* is dominant, forming nearly pure stands on undisturbed snow-free ridges; the genus is evidently rare in Wyoming.

CAREX CAPITATA L. is known from one previous collection in Wyoming (1893, *Frank Tweedy 3*, Big Horn Range, Sheridan County). It was again encountered at 11,000 feet elevation on a ridge top one mile northwest of Beartooth Pass (20 August 1958, *Johnson 55*). The species is known from Eurasia, southern South America, and Arctic North America, extending southward as far as Colorado, Utah, and Nevada (Lewis, 1958).

CAREX NELSONII Mack. is restricted to Colorado, Utah, and Wyoming. Within Wyoming three previous collections represent the species in Carbon and Albany Counties, all within 30 miles of the Colorado state line. A very substantial northern range extension is represented by plants found in a wet sedge meadow in the head of Wyoming Creek (10 August 1960, *Johnson 232*).

JUNCUS ALBESCENS (Lange) Fern. (*J. triglumis* L.) and *J. CASTANEUS* J. E. Smith are known in Wyoming by one previous collection, both from the Medicine Bow Mountains, Albany County. Both species are low Arctic-Alpine species known in Colorado. It is not surprising, then, to find them in wet stream gravel with *Juncus biglumis* L. in northern Wyoming. The collections are: *J. albescens*, *Johnson 221A*, 31 August 1959; *187B*, 29 July 1960; *205B*, August 1960; *235*, 10 August 1960; *J. castaneus*, *121B*, 31 August 1959; and *186*, 29 July 1960. All specimens were collected from wet gravel on solifluction terraces in the head of Wyoming Creek; the two species are usually found together.

Specimens of these species are deposited in the Rocky Mountain Herbarium, University of Wyoming, Laramie, Wyoming. All Johnson collections cited without initials are those of the author. Help with the identifications was received from C. L. Porter, A. E. Porsild, and Reed C. Rollins and is gratefully acknowledged. Appreciation is also expressed to the National Science Foundation for financial support under a N.S.F. grant (G-5574, W. D. Billings, Environmental Biology).

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THE UNIQUE MORPHOLOGY OF THE SPINES OF AN ARMED
RAGWEED, *AMBROSIA BRYANTII* (COMPOSITAE)¹

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The true ragweeds, wind-pollinated composites of the genus *Ambrosia*, include our most serious hay fever plants. They are generally herbs or subshrubs. Their indument commonly consists of delicate hairs and glands, although some species become more or less hispid. Spines are not characteristically borne on the vegetative body of ragweeds, in spite of the fact that most ragweed species are found in open or disturbed habitats where spiny plants are common. The species to be discussed, *A. bryantii*, is interesting not only for possessing spines, but for the nature of the spines themselves, which, to my knowledge, are unique among similar structures in vascular plants.

Armature of plants is accomplished in a number of ways, and the fact that many unrelated species possess spines is frequently used in teaching to illustrate convergent evolution. With the exception of the case of *A. bryantii*, presented below, spines which serve to protect the plant (thorns, prickles and other spine-like structures being included here under the term "spines") are formed from organs and tissues which are not directly associated with the flowers or fruits. They may be modified leaves (*Berberis thunbergii* DC.), leaf margins (*Cirsium* spp.), stipules (*Robinia pseudoacacia* L.), lateral branches (*Gleditsia triacanthos* L.), terminal shoots (*Rhamnus cathartica* L.), or epidermal emergences (*Rosa* spp.). Only one near relative of *Ambrosia* is spiny, i.e., *Xanthium spinosum* L. In this species the spines appear to be modifications of the two prophylls

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